

The opinion in support of the decision being entered today was *not* written for publication and is *not* binding precedent of the Board.

**UNITED STATES PATENT AND TRADEMARK OFFICE**

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**BEFORE THE BOARD OF PATENT APPEALS  
AND INTERFERENCES**

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*Ex parte* ZHIPING YIN and MARK E. JOST

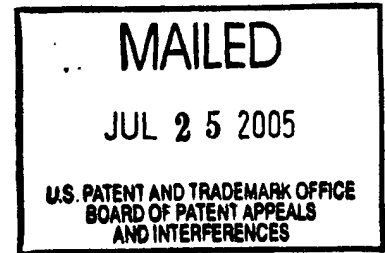
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Appeal No. 2005-0465  
Application No. 09/293,188

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ON BRIEF

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Before HAIRSTON, BARRY, BLANKENSHIP, *Administrative Patent Judges*.  
BARRY, *Administrative Patent Judge*.

A patent examiner rejected claims 1, 2, 7-10, 15-20, 29, and 30. The appellants appeal therefrom under 35 U.S.C. § 134(a). We affirm.

**I. BACKGROUND**

The invention at issue on appeal concerns "semiconductor chip processing."  
(Spec. at 2.) Semiconductor chip processing involves miniaturizing semiconductive devices and placing them on a wafer. Such devices are stacked and interconnected via tungsten (W) studs and metallization lines. (*Id.* at 2-3.)

Figure 1 of the appellant's specification shows a conventional semiconductor structure 10 featuring interconnects 12 within a dielectric layer 14. An interlayer dielectric ("ILD") 18 is deposited on the top surface 16 of the structure. After planarization of the top surface 16 or during deposition of the ILD, an oxide husk 20 forms on the top surface of the interconnect 12. Stress between the oxide husk 20 and the interconnect 12 pushes the former upward, thereby forming a void 22 above the interconnect. (*Id.* at 3.) The void 22 causes a prominence in the ILD topology, which can impede electrical contact with the interconnect 12 and can cause imaging problems. (*Id.* at 3-4.)

In contrast, before or during deposition of an ILD 18, the appellants deposit a passivation layer 22 on top of their interconnect 12. (*Id.*, Fig. 4.) A further understanding of the invention can be achieved by reading the following claims.

1. A semiconductor structure comprising:

an electrically conductive interconnect disposed within a first dielectric layer, said electrically conductive interconnect having an upper surface and comprising a metal;

a passivation layer upon said upper surface, said passivation layer comprising the chemical structure  $M-N-H_x$ , where M represents the metal of the interconnect; and

an interlayer dielectric upon said first dielectric layer and upon said upper surface, said interlayer dielectric being continuously adhered to said upper surface;

wherein the passivation layer substantially covers the upper surface of the interconnect in order to chemically protect about 1-1,000 atomic lattice layers thereof.

8. A semiconductor structure comprising:

an electrically conductive interconnect disposed within a dielectric layer, said electrically conductive interconnect having an upper surface and including:

a titanium liner layer disposed within a depression in said dielectric layer;

a titanium nitride layer disposed upon said titanium liner layer; and

a tungsten film disposed upon said titanium nitride layer and filling said depression;

a passivation layer upon said upper surface and comprising nitrogen adsorbed upon said upper surface according to Brunauer's Type V adsorption; and

an interlayer dielectric upon said dielectric layer and upon said upper surface, said interlayer dielectric being continuously adhered to said upper surface;

wherein the passivation layer substantially covers the upper surface of the interconnect in order to chemically protect about 1-1,000 atomic lattice layers thereof.

17. A semiconductor structure comprising:

an electrically conductive interconnect disposed within a first dielectric layer, said electrically conductive interconnect having an upper surface;

a first passivation layer disposed upon said upper surface, said first passivation layer comprising a tungsten nitride compound;

a second passivation layer comprising multiple layers of nitrogen compounds adsorbed upon said first passivation layer according to Brunauer's Type V adsorption; and

an interlayer dielectric disposed upon said first dielectric layer and upon said upper surface, said interlayer dielectric being continuously adhered to said upper surface;

wherein the first and second passivation layers substantially cover the upper surface of the interconnect in order to chemically protect about 1-1,000 atomic lattice layers thereof.

29. A semiconductor structure comprising:

an electrically conductive interconnect disposed within a first dielectric layer, said electrically conductive interconnect having an upper surface;

a passivation layer disposed upon said upper surface, said passivation layer comprising nitrogen; and

an interlayer dielectric disposed upon said first dielectric layer and upon said upper surface, said interlayer dielectric being continuously adhered to said upper surface;

wherein the passivation layer substantially covers the upper surface of the interconnect in order to chemically protect about 1-1,000 atomic lattice layers thereof.

Claims 1, 2, 7-10, 15-20, 29, and 30 stand rejected under 35 U.S.C. § 103(a) as obvious over U.S. Patent No. 5,780,908 ("Sekiguchi") and U.S. Patent No. 6,077,774

("Hong"). The same claims stand rejected under § 103(a) as obvious over Sekiguchi and U.S. Patent No. 6,114,238 ("Liao").

## II. OPINION

Our opinion addresses the rejections in the following order:

- claims 9, 10, 15, 16, 29, and 30
- claim 8
- claims 1 and 2
- claims 7 and 17-20.

### A. CLAIMS 9, 10, 15, 16, 29, AND 30

"[T]o assure separate review by the Board of individual claims within each group of claims subject to a common ground of rejection, an appellant's brief to the Board must contain a clear statement for each rejection: (a) asserting that the patentability of claims within the group of claims subject to this rejection do not stand or fall together, and (b) identifying which individual claim or claims within the group are separately patentable and the reasons why the examiner's rejection should not be sustained."

*In re McDaniel*, 293 F.3d 1379, 1383, 63 USPQ2d 1462, 1465 (Fed. Cir. 2002) (citing 37 C.F.R. §1.192(c)(7) (2001)). "If the brief fails to meet either requirement, the Board is free to select a single claim from each group of claims subject to a common ground

of rejection as representative of all claims in that group and to decide the appeal of that rejection based solely on the selected representative claim." *Id.*, 63 USPQ2d at 1465.

Here, the appellants stipulate *inter alia* that claims 9, 10, 15, 16, 29, and 30 "stand or fall together." (Appeal Br. at 3.) We select claim 29 from the group as representative of the claims therein.

With this representation in mind, rather than reiterate the positions of the examiner or the appellants *in toto*, we focus on the point of contention therebetween. The examiner finds, "because the passivation layer 7b of tungsten nitride in the vicinity of the surface of the interconnect (column 12, lines 29-37) is formed to a thickness of several nm for functioning as a barrier layer (column 11, lines 33-35), the passivation layer 7b would inherently chemically protect at least one atomic lattice layers of the interconnect." (Examiner's Answer at 4.) Noting that claim 29 "recite[s] . . . features of the passivation layer(s) chemically protecting about 1-1,000 atomic lattice layers of the interconnect," (Appeal Br. at 4), the appellants allege, "[t]here is no teaching or suggestion . . . of such recited features for a passivation layer(s)." (*Id.*)

In addressing the point of contention, the Board conducts a two-step analysis. First, we construe the representative claim at issue to determine its scope. Second, we determine whether the construed claim would have been obvious.

### *1. Claim Construction*

"Analysis begins with a key legal question — *what is the invention claimed?*" *Panduit Corp. v. Dennison Mfg. Co.*, 810 F.2d 1561, 1567, 1 USPQ2d 1593, 1597 (Fed. Cir. 1987). In answering the question, "the Board must give claims their broadest reasonable construction. . . ." *In re Hyatt*, 211 F.3d 1367, 1372, 54 USPQ2d 1664, 1668 (Fed. Cir. 2000). "Moreover, limitations are not to be read into the claims from the specification." *In re Van Geuns*, 988 F.2d 1181, 1184, 26 USPQ2d 1057, 1059 (Fed. Cir. 1993) (citing *In re Zletz*, 893 F.2d 319, 321, 13 USPQ2d 1320, 1322 (Fed. Cir. 1989)).

Here, claim 29 recites in pertinent part the following limitations: "the passivation layer substantially covers the upper surface of the interconnect in order to chemically protect about 1=1,000 atomic lattice layers thereof." As noted by the examiner, the representative claim "merely state[s] that about one or more lattice layers of the interconnect . . . is protected." (Examiner's Answer at 7.) Giving the representative claim its broadest, reasonable construction, the limitations require a layer that

substantially covers the top surface of an interconnect and chemically protects at least one lattice layer thereof.

## *2. Obviousness Determination*

Having determined what subject matter is being claimed, the next inquiry is whether the subject matter would have been obvious. The question of obviousness is "based on underlying factual determinations including . . . what th[e] prior art teaches explicitly and inherently. . . ." *In re Zurko*, 258 F.3d 1379, 1383, 59 USPQ2d 1693, 1696 (Fed. Cir. 2001) (citing *Graham v. John Deere Co.*, 383 U.S. 1, 17-18, 148 USPQ 459, 467 (1966); *In re Dembiczak*, 175 F.3d 994, 998, 50 USPQ 1614, 1616 (Fed. Cir. 1999); *In re Napier*, 55 F.3d 610, 613, 34 USPQ2d 1782, 1784 (Fed. Cir. 1995)). "A *prima facie* case of obviousness is established when the teachings from the prior art itself would appear to have suggested the claimed subject matter to a person of ordinary skill in the art." *In re Bell*, 991 F.2d 781, 783, 26 USPQ2d 1529, 1531 (Fed. Cir. 1993) (quoting *In re Rinehart*, 531 F.2d 1048, 1051, 189 USPQ 143, 147 (CCPA 1976)).

Here, Sekiguchi "relates to a semiconductor apparatus comprising a refractory metal, used as interconnections and electrodes for the production of



a VLSI, and a metallic interconnection formed thereon. . . ." Col. 1, ll. 8-11. "FIG. 4 shows the semiconductor apparatus. . . ." Col. 13, ll. 10-11. In manufacturing the apparatus, a "second insulating film 4 [is] deposited on [a] silicon substrate 1," *id.* at ll. 14-15, and a "contact hole 5 [is] formed in a portion of the second insulating film 4. . . ." *id.* at ll. 15-16. Later, a "tungsten film 7 . . . [is] formed within the contact hole 5." *id.* at ll. 16-19. It is uncontested that the tungsten film 7 constitutes an interconnect.

"The semiconductor apparatus further comprises [a] tungsten nitride layer 7b formed on the surface of the tungsten film 7," *id.* at ll. 19-21, more specifically on the "top surface of the refractory metal film." Col. 4, ll. 55-56. "[T]he tungsten nitride layer . . . serv[es] as a barrier layer," col. 10, ll. 46-47, by which an "alloy of tungsten and aluminum is prevented from being formed by the counter diffusion of tungsten and aluminum even when the annealing for the recovery of the damage and the like is thereafter conducted" *id.* at ll. 48-51. Such "counter diffusion of tungsten and aluminum causes a [chemical] reaction between the tungsten and the aluminum, so as to form an alloy of tungsten and aluminum (such as  $WAl_{12}$ )." Col. 3, ll. 25-29. Because the barrier layer 7b prevents a chemical reaction between tungsten and aluminum, we find that it chemically protects the tungsten interconnect 7. Because the barrier layer is "several nm" thick, col. 11, l. 34, moreover, we agree with the examiner's finding that it so protects "at least one atomic lattice layers of the interconnect." (Examiner's Answer

at 4.) Therefore, we affirm the obviousness rejections of claim 29 and of claims 9, 10, 15, 16, and 30, which fall therewith.

## B. CLAIM 8

Asserting that "the process of performing 'Brunauer's Type V adsorption' does not carry weight in a claim drawn to structure," (Examiner's Answer at 9), the examiner finds, "Sekiguchi does suggest a passivation layer 7b comprising nitrogen adsorbed upon the upper surface of tungsten interconnect 7 because the passivation layer 7b of tungsten nitride (WN) is formed by exposing the surface of the tungsten interconnect 7 to plasma in an atmosphere of ammonia (NH<sub>3</sub>) for nitriding an area in the vicinity of the surface of the tungsten interconnect 7 (column 15, lines 50-58)." (*Id.*) Observing that "[c]laim 8 recites that a passivation layer comprises 'nitrogen adsorbed upon said upper surface according to Brunauer's Type V adsorption,'" (Appeal Br. at 4), the appellants allege, "[t]here is no teaching or suggestion . . . of such recited features for a passivation layer, and no teaching of what if any type of adsorption is present." (*Id.*)

### *1. Claim Construction*

Claim 8 recites in pertinent part the following limitations: "a passivation layer upon said upper surface and comprising nitrogen adsorbed upon said upper surface according to Brunauer's Type V adsorption. . . ." Giving the claim its broadest,

reasonable construction, the limitations specify a layer that includes nitrogen (N), which is adsorbed according to Brunauer's Type V adsorption, and protects the top surface of an interconnect.

## *2. Obviousness Determination*

"[T]he Patent Office bears a lesser burden of proof in making out a case of *prima facie* obviousness for product-by-process claims because of their peculiar nature than would be the case when a product is claimed in the more conventional fashion." *In re Fessman*, 489 F.2d 742, 744, 180 USPQ 324, 326 (CCPA 1974). "[E]ven though product-by-process claims are limited by and defined by the process, determination of patentability is based on the product itself. The patentability of a product does not depend on its method of production. If the product in a product-by-process claim is the same as or obvious from a product of the prior art, the claim is unpatentable even though the prior product was made by a different process." *In re Thorpe*, 777 F.2d 695, 698, 227 USPQ 964, 966 (Fed. Cir. 1985) (citations omitted).

Here, being formed of tungsten nitride (WN), Sekiguchi's barrier layer 7b includes nitrogen. As explained regarding claims 9, 10, 15, 16, 29, and 30, moreover, the barrier layer chemically protects the tungsten interconnect 7. Because the claimed "passivation layer" is the same as or obvious from the barrier layer, the claim is

unpatentable regardless of whether the nitrogen of the barrier layer was adsorbed according to Brunauer's Type V adsorption. Therefore, we affirm the obviousness rejections of claim 8.

### C. CLAIMS 1 AND 2

The appellants stipulate that claims 1 and 2 "stand or fall together." (Appeal Br. at 3.) We select claim 1 from the group as representative of the claims therein.

The examiner makes the following findings.

[F]irst, Sekiguchi clearly discloses a passivation layer comprising the chemical structure of M-N-H. Specifically, Sekiguchi (Fig. 3b) discloses the passivation layer 7b of tungsten nitride (WN) disposed upon the upper surface of a tungsten interconnect 7. The passivation layer 7b is formed by exposing the surface of the tungsten interconnect 7 to plasma in an atmosphere of ammonia (NH<sub>3</sub>) for nitriding an area in the vicinity of the surface of the tungsten interconnect 7 (column 15, lines 50-58), wherein the plasma in an atmosphere of ammonia **allows ions of ammonia (NH<sub>3</sub>) to enter the surface of tungsten interconnect 7** (column 11, lines 28-35). Therefore, the passivation layer 7b of tungsten nitride (WN) would inherently include hydrogen ions(H) from the ammonia source gas and form the chemical structure W-N-H (or M-N-H) (W is tungsten; N is nitrogen; H is hydrogen; and M is generally a metal);

[S]econd, Sekiguchi discloses the forming of the passivation layer 7b which appears to be produced by **substantially identical processes** as disclosed by Appellant (i.e., nitriding the conductive interconnect in ammonia atmosphere) (see Appellant's specification, second paragraph of page 10). Therefore, the passivation layer of Sekiguchi and the

passivation layer of Appellant must have the same chemical structure because they are both produced by identical processes. . . .

(Examiner's Answer at 5-6.) Observing that "[c]laim 1 recites that the passivation layer comprises 'the chemical structure M-N-H<sub>x</sub>, where M represents the metal of the interconnect,'" (Appeal Br. at 4), the appellants allege, "[t]here is no teaching or suggestion . . . of such recited features for a passivation layer(s)." (*Id.*)

### *1. Claim Construction*

Claim 1 recites in pertinent part the following limitations: "said passivation layer comprising the chemical structure M-N-H<sub>x</sub>, where M represents the metal of the interconnect. . . ." Giving the representative claim its broadest, reasonable construction, the limitations require that a protective layer comprises the chemical structure MNH<sub>x</sub>, where M represents the metal of the protected interconnect.

### *2. Obviousness Determination*

To form the aforementioned barrier layer 7b, Sekiguchi exposes the surface of the tungsten interconnect 7 "to plasma with high frequency power of 300 W at a temperature of 50°C," col. 12, ll. 31-33, in an atmosphere of NH<sub>3</sub> gas, col. 15, l. 52, "at a pressure of 80 mTorr for one minute, thereby nitriding an area in the vicinity of the surface of the tungsten film 7. . . ." Col. 12, ll. 34-36. Upon such exposure, "the

[barrier] layer is formed by allowing ions in the plasmatic state around the substrate to enter the tungsten film. . . ." Col. 11, ll. 29-31. Because ions from the  $\text{NH}_3$  would enter the W, we agree with the examiner's finding that the barrier layer 7b includes hydrogen (H) ions and comprises the chemical structure  $\text{WNH}_x$ , where W is the tungsten of the protected interconnect 7. Therefore, we affirm the obviousness rejections of claim 1 and of claim 2, which falls therewith.

#### D. CLAIMS 7 AND 17-20

The appellants stipulate that claims 7 and 17-20 "stand or fall together." (Appeal Br. at 3.) We select claim 17 from the group as representative of the claims therein.

Again asserting that "the process of performing 'Brunauer's Type V adsorption' does not carry weight in a claim drawn to structure," (Examiner's Answer at 8), the examiner finds, "in the final structure, the passivation layer comprising a stack of first and second passivation layers as claimed does not distinguish from the passivation layer 7b of tungsten nitride comprising ammonia derivatives (N and H) of Sekiguchi which can be arbitrarily subdivided into numerous sub-layers about each other." (*Id.* at 8-9.) Observing that claim 17 recites "that a second passivation layer comprises 'multiple layers of nitrogen compounds adsorbed upon said first passivation layer according to Brunauer's Type V adsorption,'" (Appeal Br. at 4), the appellants allege,

"[t]here is no teaching or suggestion . . . of such recited features for a passivation layer, and no teaching of what if any type of adsorption is present." (*Id.*)

### 1. Claim Construction

Claim 17 recites in pertinent part the following limitations: "a first passivation layer disposed upon said upper surface, said first passivation layer comprising a tungsten nitride compound; a second passivation layer comprising multiple layers of nitrogen compounds adsorbed upon said first passivation layer according to Brunauer's Type V adsorption. . . ."<sup>1</sup> Giving the representative claim its broadest, reasonable construction, the limitations specify a layer that includes tungsten nitride and a layer that includes nitrogen, the layers protecting the top surface of an interconnect, and the nitrogen of the latter layer adsorbed according to Brunauer's Type V adsorption.

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<sup>1</sup>"The drawing[s] in a nonprovisional application must show every feature of the invention specified in the claims." 37 C.F.R. § 1.83(a) (1998). "Any structural detail that is of sufficient importance to be described should be shown in the drawing." M.P.E.P. § 608.02(d) (7th ed. July 1998) (citing *Ex parte Good*, 1911 C.D. 43, 164 O.G. 739 (Comm'r Pat. 1911)). Here, we were unable to find the two passivation layers in the appellants' drawings. The drawings show only a single passivation layer 32. We leave the question of satisfaction of the aforementioned authorities to the examiner and the appellants.

## *2. Obviousness Determination*

As explained regarding claims 1, 2, and 8, when formed by exposing the surface of the W interconnect 7 to plasma in an atmosphere of  $\text{NH}_3$  gas, Sekiguchi's barrier layer 7b includes W, N, and H. We agree with the examiner's finding, moreover, that the layer 7b can be viewed as "subdivided into numerous sub-layers about each other." (Examiner's Answer at 9.) Because the barrier layer comprises the  $\text{WNH}_x$ , we find that each sublayer thereof includes WN and includes N, the layers protecting the top surface of an interconnect. Because the claimed "passivation layer[s]" are the same as or obvious from the barrier layer, the representative claim is unpatentable regardless of whether the N of the barrier layer was adsorbed according to Brunauer's Type V adsorption. As explained regarding claims 9, 10, 15, 16, 29, and 30, moreover, the barrier layer chemically protects the tungsten interconnect 7. Therefore, we affirm the obviousness rejections of claim 17 and of claims 7 and 18-20, which fall therewith.

## CONCLUSION

In summary, the rejections of claims 1, 2, 7-10, 15-20, 29, and 30 under § 103(a) are affirmed.

"Any arguments or authorities not included in the brief will be refused consideration by the Board of Patent Appeals and Interferences. . . ." 37 C.F.R.




§ 1.192(a). Accordingly, our affirmance is based only on the arguments made in the brief. Any arguments or authorities omitted therefrom are neither before us nor at issue but are waived. *Cf. In re Watts*, 354 F.3d 1362, 1367, 69 USPQ2d 1453, 1457 (Fed. Cir. 2004) ("[I]t is important that the applicant challenging a decision not be permitted to raise arguments on appeal that were not presented to the Board.") No time for taking any action connected with this appeal may be extended under 37 C.F.R.

§ 1.136(a)(1)(iv).

  
KENNETH W. HAIRSTON  
Administrative Patent Judge

LANCE LEONARD BARRY  
Administrative Patent Judge

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